W91321-04-C-0023

LOGANEnergy Corp.

Hill AFB PEM Demonstration Project
Final Project Report

Proton Exchange Membrane (PEM) Fuel Cell Demonstration
Of Domestically Produced PEM Fuel Cells in Military Facilities

US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
Broad Agency Announcement CERL-BAA-FY03

Hill Air Force Base
Main Base Fire Station, Building #9
Ogden, Utah

May 25, 2006

Executive Summary

Under terms of its FY'03 DOD PEM Demonstration Contract with ERDC/CERL, LOGANEnergy installed and operated for 1 year a Plug Power GenSys5C 5kWe Combined Heat and Power fuel cell power plant, S/N B320 at Hill AFB. The site selected for the one-year demonstration project was Building 9, the Base Fire Station. The unit was electrically configured to provide grid parallel/grid independent service to the fire station and it was also thermally integrated with the facility's hot water system to support domestic hot water loads. This project added $952 in annual energy costs to Hill ARB during the period of performance.

Hill AFB receives its utility services from Utah Power and Utah Gas.

The project started in February 2005 and ended in March 2006, during which time the installation achieved 97% availability and accumulated 23,700kWh.

The Hill AFB POC for this project was David Abbott, who may be reached at:
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75 CES/CEEE Hill AFB, UT
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Proposal – Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

1.0 Descriptive Title

LOGANEnergy Corp. Small Scale PEM 2004 Demonstration Project at Hill AFB in Ogden, UT

2.0 Name, Address and Related Company Information

LOGANEnergy Corporation
1080 Holcomb Bridge Road
BLDG 100- 175
Roswell, GA 30076
(770) 650- 6388

DUNS 01-562-6211
CAGE Code 09QC3
TIN 58-2292769

LOGANEnergy Corporation is a private Fuel Cell Energy Services company founded in 1994. LOGAN specializes in planning, developing, and maintaining fuel cell projects. In addition, the company works closely with manufacturers to implement their product commercialization strategies. Over the past decade, LOGAN has analyzed hundreds of fuel cell applications. The company has acquired technical skills and expertise by designing, installing and operating over 30 commercial and small-scale fuel cell projects totaling over 7 megawatts of power. These services have been provided to the Department of Defense, fuel cell manufacturers, utilities, and other commercial customers. Presently, LOGAN supports 30 Phosphoric Acid Fuel Cells (PAFC) and PEM fuel cell projects at 21 locations in 12 states, and has agreements to install 22 new projects in the US and the UK over the next 18 months.

3.0 Production Capability of the Manufacturer

Plug Power manufactures a line of PEM fuel cell products at its production facility in Latham, NY. The facility produces three lines of PEM products including the 5kW GenSys5C natural gas unit, the GenSys5P Liquid Propane Gas (LPG) unit, and the GenCore 5kW standby power system. The current facility has the capability of manufacturing 10,000 units annually. Plug Power will support this project by providing remote monitoring, telephonic field support, overnight parts supply, and customer support. These services are intended to enhance the reliability and performance of the unit and achieve the highest possible customer satisfaction. Vinny Cassala is the Plug Power point of contact for this project. His phone number is 518.782.7700 ex. 1228, and his email address is vincent_cassala@plugpower.com.

4.0 Principal Investigator(s)

Name	Chris Davis	Keith Spitznagel
Title	COO	Vice President Market Engagement
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5.0 Authorized Negotiator(s)

Name	Chris Davis	Keith Spitznagel
Title	COO	Vice President Market Engagement
Company	Logan Energy Corp.	Logan Energy Corp.
Phone	770.650.6388 x 102	860.210.8050
Fax	770.650.7317	770.650.7317
Email	cdavis@loganenergy.com	kspitznagel@loganenergy.com

6.0 Past Relevant Performance Information

a) Contract: PC25 Fuel Cell Service and Maintenance Contract #X1237022

Merck & Company
Ms. Stephanie Chapman
Merck & Company
Bldg 53 Northside
Linden Ave. Gate
Linden, NJ 07036
(732) 594-1686

In November 2002 Merck & Company issued a four-year contract to LOGAN to provide fuel cell service, maintenance and operational support for one PC25C fuel cell installed at their Rahway, NJ plant. During the contract period the power plant has operated at 94% availability. LOGAN performs the quarterly and annual service prescribed by the UTC, and performs other maintenance as required. The periods of unavailability are chiefly due to persistent inverter problems that seem to be endemic to the Toshiba power conditioning balance of the system. Field modifications and operating adjustments have largely cured the problem. Quarterly service events take 10 hours to complete with the unit under load, and the annual event takes approximately 35 hours with the unit shut down.

b) Contract: Plug Power Service and Maintenance Agreement to support one 5kWe GenSys5C and one 5kWe GenSys5P PEM power plant at NAS Patuxant River, MD.

Plug Power
Mr. Vinny Cassala.
968 Albany Shaker Rd.
Latham, NY 12110
(518) 782-7700 ex 1338

LOGAN performed the start-up of both units after Southern Maryland Electric Cooperative completed most of the installation work. The units are located at residential sites at Patuxant

River Naval Air Station, MD and operate in standard gird connected/grid independent configurations. Both operate at 4.5kWe and have maintained 98% availability. The units, S/Ns 241 and 242 are two of the very latest GenSys models to reach the field. S/N 242 is Plug Power's first LPG fueled system to go into the field. Both have set new performance standards, and raised expectations for near term commercial viability for this product. Operations to date are indicative of the success of the various test and evaluation programs that have been conducted over the past two years.

c) Contract: A Partners LLC; Commercial PC25 Fuel Cell Project Design, Installation and 5-year service and maintenance agreement.

Mr. Ron Allison
A Partners LLC
1171 Fulton Mall
Fresno, CA 93721
(559) 233-3262

On April 20, 2004 LOGAN completed the installation of a 600kWe PC25C Combined Heat and Power (CHP) fuel cell installation in Fresno, CA. The system operating configurations allow for both grid parallel and grid independent energy service. The grid independent system is integrated with a Multi Unit Load Sharing (MULS) electronics package and static switch, which initial development was funded by ERDC CERL in 1999. This is the third fuel cell installation that uses the MULS System. The thermal recovery package installed in the project includes a 100-ton chiller that captures 210 degree F thermal energy supplied by the three fuel cells to support cooling loads on the first three floors of the host facility. The fuel cells also provide low-grade waste heat at 140 degrees F that furnishes thermal energy to 98 water source heat pumps located throughout the 12-story building during the winter months.

7.0 Host Facility Information

Hill Air Force Base is an Air Force Material Command base located in northern Utah. Hill is home to many operational and support missions, with the Ogden Air Logistics Center (OO-ALC) serving as the host organization. The center provides worldwide engineering and logistics management for the F-16 Fighting Falcon, A-10 Thunderbolt, Minuteman III and Peacekeeper Intercontinental Ballistic Missiles. The base performs depot maintenance of the F-16, A-10 and C-130 Hercules aircraft.

The center is responsible for Air Force-wide item management, depot-level overhaul and repair for all types of landing gear, aircraft wheels, brakes and tires. The logistics for all

conventional air munitions, solid propellants and explosive devices used throughout the Air Force are managed at Hill AFB. The OO-ALC is the Air Force Center of Industrial and Technical Excellence (CITE) for low-observable “stealth” aircraft structural composite materials and provides support for the B-2 Spirit multi-role bomber.

A full range of sustainable and logistics support is provided for space and command, control, communication and intelligence systems. The center provides worldwide logistical support for mature (T-37, T-38) and proven (F-4, F-5, F-111, OV-10) aircraft.

Hill is also responsible for providing photonics imaging and reconnaissance equipment; aircraft and missile crew training devices; avionic, hydraulic, pneumatic and radar components; instruments; gas turbine engines; power equipment systems; special purpose vehicles; shelters; and software engineering, development and support.

Hill AFB is located right off Interstate 15, about 30 miles north of Salt Lake City. Once you get on base through the South, West or the Roy Gates, security will direct you to parking. Hill is located along the Wasatch Front, the mountain chain just to the east. To the north of the base, the closest major city is Ogden.

8.0 Fuel Cell Installation

The photo below in Figure 2 is a picture of the entrance to the Hill AFB Fire Station Building #9, which hosted the PEM project. Following the initial site visit on July 15, 2004, LOGAN and the base POC reached an initial consensus that the Base Wing Commander's residence could provide a good opportunity to install the fuel cell to best effect. However, during the kick-off meeting on July 27, 2004, the POC revealed that the new base housing privatization program would prevent that original plan from going forward. In the ensuing discussions, the Hill POC and LOGAN decided to tour the base fire station to determine its suitability for the project. Following that, this facility was chosen to host the project.

The photo below in Figure 1 shows the installation location prior to the start of the project at the rear of the Building 9. Note the convenient location of natural gas service on the building exterior wall behind the bollards. Gas piping penetrates the building at a point just below the regulator and terminates at a hot water heater located in a closet 15 feet from the exterior wall. LOGAN used the same wall penetration and routing to install its thermal recovery piping to the water tank.

The building did not originally have high speed Ethernet service, but the POC assisted in acquiring the service during the installation phase. The installation plan simulated a critical load application by wiring lighting circuits to the fuel cell's emergency load panel.

Figure 1

Figure 2

The photos below show the fuel cell pad site during and after the installation phase at Hill Air Force Base Building #9. Figure 3, below, shows the fuel cell on its pad site, looking to the North. Behind the fuel cell and to the left is the door to the mechanical room, where technicians could easily gain access to the heat recovery components and water filtration equipment. The photograph also shows two bollards that were installed to in front of the unit to safeguard against vehicular traffic moving behind the facility.

The second photo below, labeled Figure 4, shows the heat recovery accessories that were tied into the facility's hot water heater. The brown component is the circulation pump that maintains CHP flow between the fuel cell and the Solar Wand. The solar wand is the key heat transfer element in the CHP loop which maintains direct contact with the water within the tank.

Figure 3

Figure 4

Figure 5

Reverse Osmosis (R/O) filtration equipment installed by LOGAN technicians can be seen on the inside wall of the maintenance room in Figure 5, to the left. The blue housing contains a carbon filter and the gray filter toward the back serves as the R/O unit to the fuel cell.

The piping that exits the wall toward the bottom of Figure 5 is the insulated heat recovery loop. This piping runs to the facility hot water heater seen above in Figure 4.

9.0 Electrical System

The Plug Power GenSys5C PEM fuel cell power plant provided both grid parallel and grid independent operating configurations for site power management. This capability was an important milestone in the development of the GenSys5 product commercialization schedule. The unit has a power output of 110/120 VAC single phase at 60 Hz. The photo below in Figure 6 shows the electrical service panel in the fire station where the fuel cell was electrically coupled to

the base utility grid. On the wall adjacent to the service panel, LOGAN attached a new emergency service panel that connected the fuel cell emergency power to lighting circuits.

Figure 6

Figure 7

Figure 7, above, shows the mounting bracket that has been fixed to the side of the Hill AFB GenSys5C unit. LOGAN technicians placed the fuel cell emergency disconnect and electric meter on the bracket.

10.0 Thermal Recovery System

The thermal recovery system installed by LOGAN at Hill Air Force Base investigated a new heat exchange technology through the use of Butler Sun Solutions' Solar Wand. LOGAN opted for this heat exchanger component in place of the Heliodyne, used at previous sites, in order to add component diversity and investigate the possible benefits afforded by a different heat exchanger design. While the Heliodyne has proven highly reliable and efficient in previous GenSys PEM demonstrations, the Solar Wand allowed LOGAN to expand the heat exchanger possibilities for future CHP sites.

The Butler Sun Solutions Solar Wand was designed to allow standard hot water tanks to make use of solar heating, but proved adaptable to this fuel cell application. The Solar Wand is a double-walled heat exchanger that inserts into any standard domestic hot-water tank. The apparatus screws into the outlet port of the tank, providing a new hot water outlet and also fluid input/output connections. The Solar Wand itself provides approximately two square feet of heat transfer surface inside the tank. The heat exchange medium at the Hill site was a 50/50 mixture of propylene glycol and water, and was isolated from the potable hot water by two copper wall barriers. The Solar Wand allowed LOGAN to use the existing hot water tank and a single pump to circulate fluid from the fuel cell o the Solar Wand. Figure 8 below shows the Solar Wand component on its own as well as a close-up of the installed heat exchanger on the water heater.

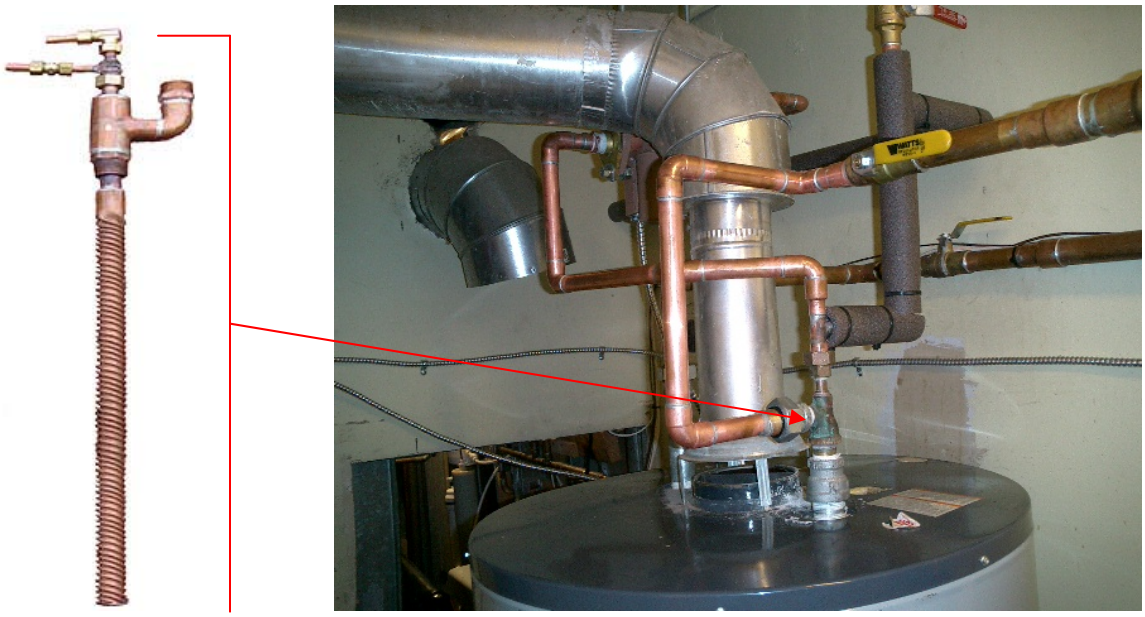


Figure 8

11.0 Data Acquisition System

LOGAN installed a Connected Energy Corporation (CEC) web-based Supervisory Control And Data Acquisition (SCADA) system that provides high-speed, real-time monitoring of the power plant. The schematic drawing seen below in Figure 9 describes the architecture of the CEC hardware that supports the project. The system provides a comprehensive data acquisition solution and also incorporates remote control, alarming, notification, and reporting functions. The system picks up and displays a number of fuel cell operating parameters on functional display screens including: kWh, cell stack voltage, water management, as well as external instrumentation inputs including Btus, fuel flow, and thermal loop temperatures. LOGAN's Operations Control Center in Rochester, New York maintains connectivity by means of a Virtual Private Network (VPN) that will link the fuel cell to the center.

CEC WEB enabled SCADA Terminal Hardware

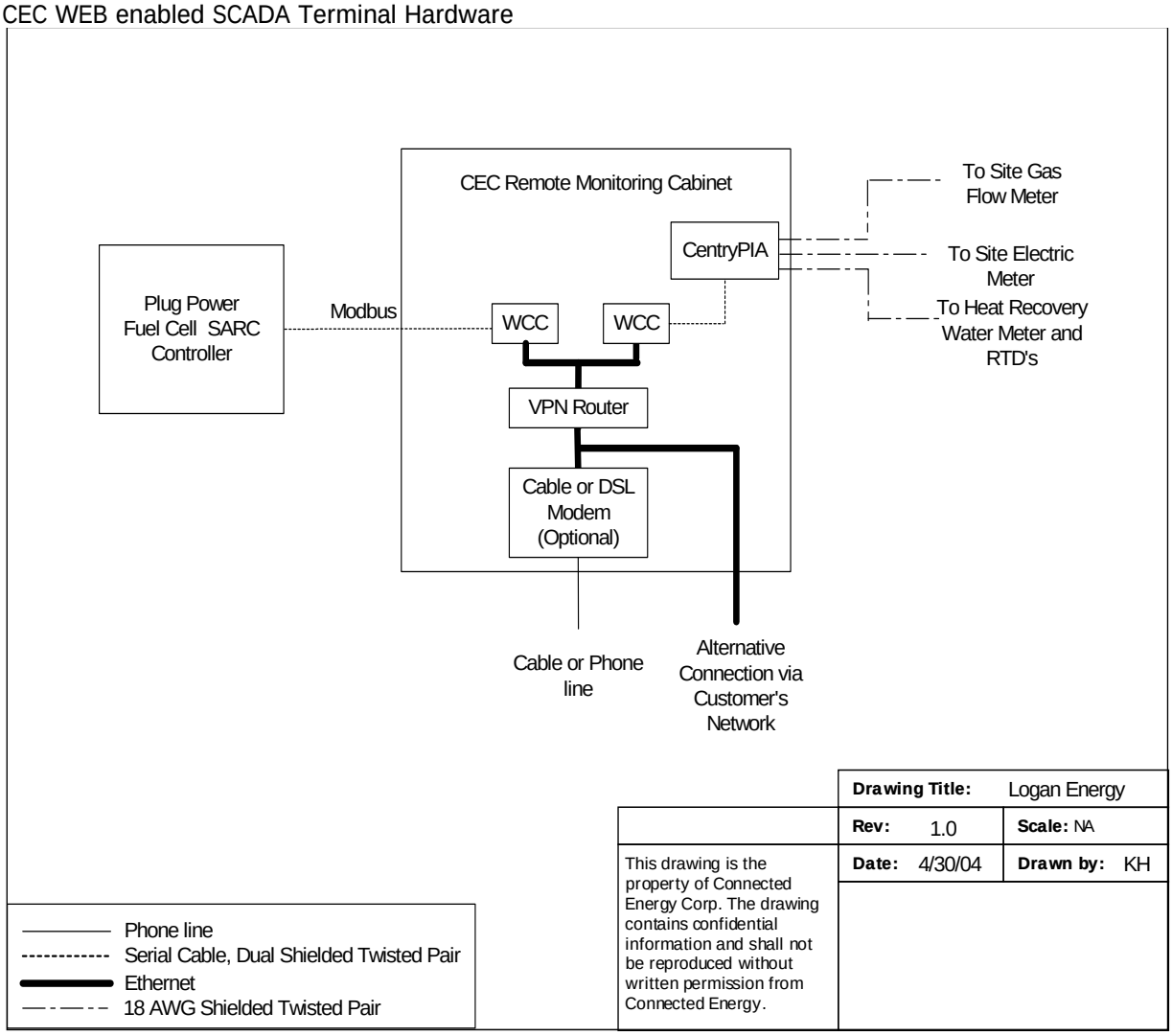


Figure 9

High-speed Internet access via the VPN router, pictured in the Figure 9 schematic, has been contracted with a local Internet Service Provider (ISP). The base provided dial tone to a phone jack that is conveniently located in the basement of Building #9 to provide analog communications with the fuel cell data modem.

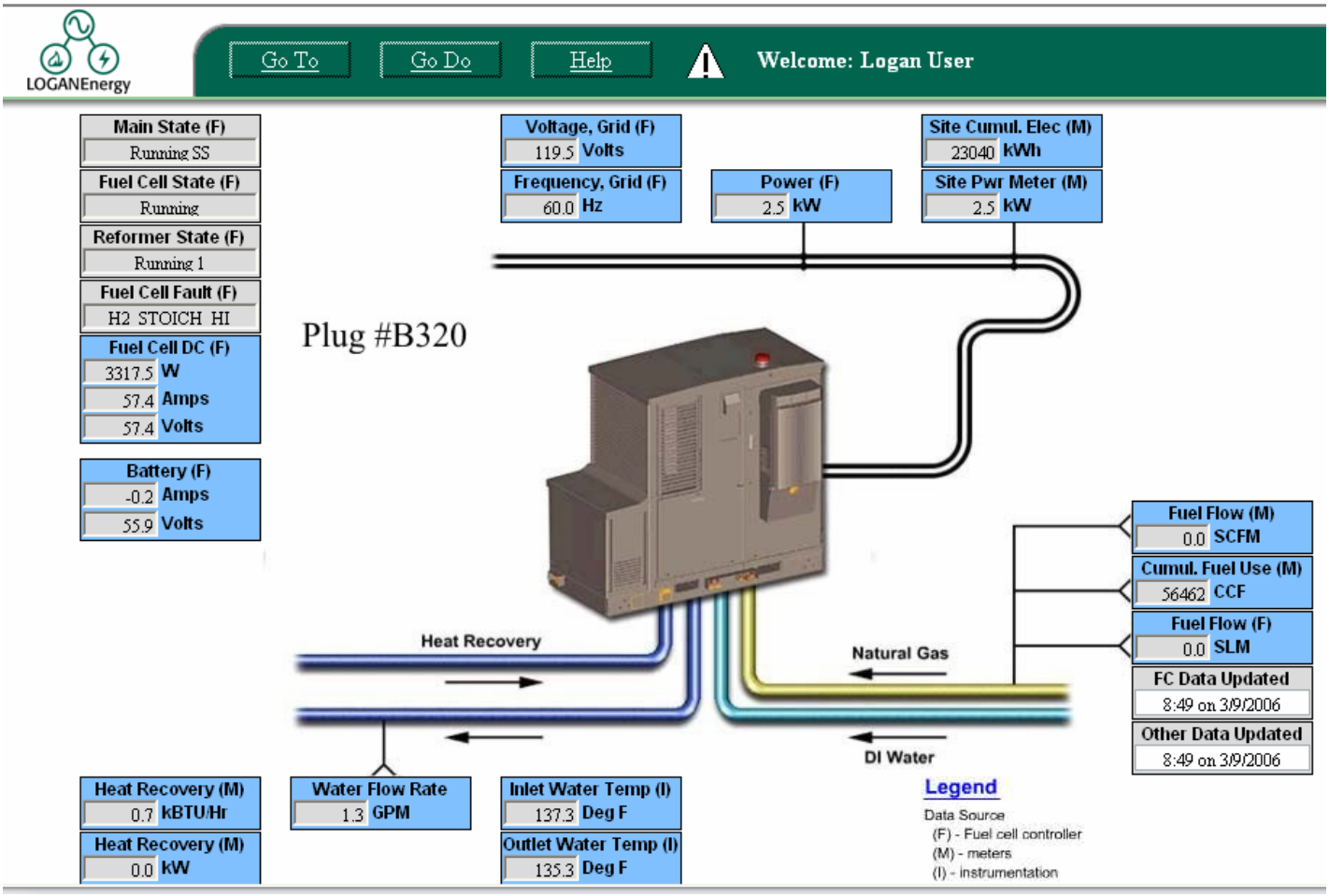


Figure 10, Connected Energy Web Data Screen from 10:00 AM on 3/9/06 showing a number of performance data points for S/N B320, the GenSys serial number of the Hill AFB unit.

To view the operation of this unit online, go to: https://www.enerview.com/EnerView/login.asp Then login as: logan.user and enter the Password: guest. Select the box labeled GA Tech ROTC. Then you may navigate the site or other LOGAN sites using the tool bars or html keys.

12.0 Fuel Supply System

LOGAN connected the fuel cell gas piping into the existing natural gas service line adjacent to the fuel cell pad, and installed a flow meter to calculate fuel cell usage as mentioned in Figure 1. A regulator at the fuel cell gas inlet maintained the correct fuel cell operating pressure at 14 inches water column.

13.0 Program Costs

Hill Air Force Base Fire Station Building #9

Project Utility Rates		**Utility**
1) Water (per 1,000 gallons)	$0.95	Hill AFB
2) Utility (per KWH)	$0.0473	Utah Power
3) Natural Gas (per MCF)	$8.29	Utah Gas

First Cost	**Estimated**	**Actual**	**Variance**
Plug Power 5 kW GenSys5C	$ 65,000.00	$ 65,000.00	**$ -**
Shipping	$ 1,800.00	$ 1,060.00	**$ (740.00)**
Installation electrical	$ 1,250.00	$ 924.00	**$ (326.00)**
Installation mechanical & thermal	$ 3,200.00	$ 1,700.00	**$ (1,500.00)**
Watt Meter, Instrumentation, Web Package	$ 3,150.00	$ 2,950.00	**$ (200.00)**
Site Prep, labor materials	$ 925.00	$ 1,125.00	**$ 200.00**
Technical Supervision/Start-up	$ 8,500.00	$ 8,500.00	**$ -**
Decommissining and site restoration			
Total	**$ 83,825.00**	**$ 81,259.00**	**$ (2,566.00)**
Assume Five Year Simple Payback	$ 16,765.00	$ 16,251.80	**$ (513.20)**

Operating Expenses	Volume	$/Hr	$/ Yr		
Natural Gas MCF/ hr @ 2.5kW	0.03	$ 0.27	$ 2,146.24		
Water Gallons per Year	14,016		$ 13.32		
Total Annual Operating Expenses				$ 2,159.55	
Project management & reporting costs			$ 14,000.00	$ 14,025.00	$ (25.00)
Technical service and maintenance costs			$ 24,900.00	$ 23,963.00	$ 937.00
Total costs			$ 38,900.00	$ 40,147.55	$ (1,247.55)

Economic Summary			
Annual kWH		23700	
Annual Cost of Operating Power Plant	$	0.091	kWH
Credit Thermal Recovery Rate		($0.004)	kWH
Project Net Operating Cost	$	0.087	kWH
Displaced Utility cost	$	0.0473	kWH
Energy Savings (Cost)		($0.040)	kWH
Annual Energy Savings (Cost)		($952.28)	

Explanation of Calculations:

Actual First Cost Total is a *sum* of all the listed first cost components.
Assumed Five Year Simple Payback is the Estimated First Cost Total *divided by* 5 years.

Forecast Operating Expenses:
Natural gas usage in a fuel cell system set at 2.5 kW will consume 0.033 MCF per hour. The cost per hour is 0.033 MCF per hour *x* the cost of natural gas to the site per MCF at $8.29. The cost per year of $2,146.24 is the cost per hour at $0.27 *x* 8760 hours per year *x* 0.9. The 0.9 is for 90% availability.
Natural gas fuel cell systems set at 2.5 kW will consume 1.6 gallons of water per hour through the Deionized water (DI) panel. The total volume of water consumed at 14,016 gallons per year is 1.6 gph *x* 8760 hours per year. The cost per year of $13.32 is 14,016 gph *x* cost of water to the site at $0.95 per 1000 gallons.

The Total Annual Operating Expense, $2,159.55 is the *sum of* the cost per year for the natural gas and the cost per year for the water consumption.

Economic Summary:
The Forecast Annual kWh at 19,710 kWh is the product of the 2.5 kW set-point for the fuel cell system *x* 8760 hours per year *x* 0.9. The 0.9 is for 90% availability.
The Annual Cost of Operating the Power Plant at $.091 per kWh is the Total Annual Operating Cost at $2,159.55 *divided by* the forecast annual kWh at 23,700 kWh.
The Credit Annual Thermal Recovery at $0.004 is the value of gas savings, $95.79/ 23700kWh. As a credit to the cost summary, the value is expressed as a negative number.
The Project Net Operating Cost is the *sum* of the Annual Cost of Operating the Power Plant *plus* the Credit Annual Thermal Recovery.
The Displaced Utility Cost is the cost of electricity to Hill AFB per kWh.

Energy Savings (cost) equals the Displaced Utility Cost *minus* the Project Net Operating Cost.
Annual Energy Savings (cost) equals the Energy Savings *x* the Forecast Annual kWh.

14.0 Milestones/ Improvements

Beginning with the FY'03 DOD PEM demonstration program LOGANEnergy introduced a new pulse-controlled metering component that at first appeared to reduce costs while also diversifying the heat recovery systems being used in the field. The new hardware selected was the ISTEC BTU/flow meter, which can be configured to deliver varying output signals depending on the type of data required by the logging equipment.

The output of the ISTEC BTU meter is a pulse which signifies BTU recovery across the heat exchanger. This seemed to be a simpler installation and a more reliable solution than the costly Omega systems that had been the meter of choice for two years. After several months of difficulty with capturing accurate data from the ISTEC, and following extensive troubleshooting to understand the problem, LOGAN determined that the ISTEC operating configuration conflicted with the Connected Energy data-logging software. At the FY'01 and FY'02 sites, the Omega flow meter and RTD sensors provided inputs to the Connected Energy software that enabled it to calculate heat recovery as BTUs. However, LOGAN found that the ISTEC heat recovery values calculated internally were not an acceptable format for the Connected Energy programming, and therefore the data could not be recorded or displayed properly.

This discovery grew out of the experience at Hill AFB and as a result LOGAN has been able to correct similar data-logging problems at the sites using ISTEC BTU meters. The technicians in charge of each of these sites have reconfigured the ISTEC metering hardware to relay only flow-rate pulses to the Connected Energy data-logging components rather than calculated BTUs. RTDs sensors have been added at each of these sites in order to capture water temperatures that are necessary to meet the requirements of the Connected Energy BTU calculation scheme. At this time LOGAN is working closely with Connected Energy to ensure that future thermal data will be collected accurately for the remainder of these demonstrations. A graph in Figure 12 of Appendix 2 displays the newly corrected thermal recovery data-logging setup with Connected Energy. The changes used at Hill AFB have been universally applied at the rest of the ISTEC sites in order to ensure accurate thermal data collection for the remainder of these projects.

15.0 Decommissioning

This site will be decommissioned by the end of September 2006. Prior to this point there has been discussion about extending the service life of the unit, however Plug has decided to close down the SU-1 product line as existing projects terminate. The deliberation over that point has caused the delay in removing the unit.

16.0 Additional Research/ Analysis

After having completed over two dozen prior CERL PEM demonstration sites in which the CHP application involved the use of a Heliodyne heat exchanger to transfer fuel cell process heat transfer into hot water tanks, LOGAN decided to investigate a new heat exchanger with this site. The decision to use the Solar Wand was also partly motivated by the opportunity to save approximately $800 in installation costs. Figure 8 above pictures Solar Wand as installed in the hot water tank as previously explained in paragraph 10 above.

The operating and performance of the Solar Wand proved to be very satisfactory as compared with the more expensive Heliodyne system used at all previous sites. Several Operating Performance Graphs are provided in Appendix section 2 that provide insight into the capability of this lower cost method and will enable the reader to analyze the performance of the fuel cell at this site. The presentations are as follows:

A. Figure 11, Daily Heat Recovery Temperature Delta from July 2005 through March 2006 in KBTU/H
B. Figure 12, Daily Heat Recovery Rate in KBTU/hr. from July 2005 through March 2006
C. Figure 13, Plot of cumulative fuel consumption, blue line, over cumulative power, red line
D. Figure 14, Overall System Efficiency (%) from March 2005 through March 2006
E. Figure 15, Fuel Cell Electrical Production

The data key is described at the bottom of each graph.

Additional Analysis from Appendix Section 2, - Current Waveform and Voltage Waveform Harmonics

This section presents site data gathered from testing and verification of performance specifications of the GenSys5 AC inverter. The data describes two conditions; a. current waveform harmonics, and b. the voltage waveform harmonics. The IEEE Standard, 519-1992, that governs the performance of the Plug Power Su-1 states that

1. Total Voltage Harmonic Distortion at rated inverter output is limited to 5% of fundamental frequency voltage, and
2. Individual Frequency Harmonics Distortion is limited to 3% of fundamental frequency voltage.

Referring to the Charts in Appendix 2, the test results indicate that at the time the measurements were taken, total voltage harmonic distortion of 2.2% was well below the upper IEEE limit of 5%.

17.0 Conclusion/ Summary

This project had a very strong partner in the Hill AFB Energy Management Office led by Dave Abbott. The installation received great support as a high profile technology demonstration on the base. During the period of performance, occurring over 13 months, the fuel cell achieved 97% availability. Even though the travel time and distance to support his unit was a challenge, in many respects it stimulated better resource planning and parts supply; but fortunately the unit's operating performance exceeded expectations by a factor of 3. This project also enhanced LOGAN's capabilities around project planning for distant operations, remote monitoring and

troubleshooting and therefore it contributed to a more rapid expansion the company's fuel cell knowledge base and its confidence in deploying DOD fuel cell systems.

There were other milestones. The Hill AFB project was the first to field and test a Solar Wand external heat exchanger that proved as reliable as other systems but at a fraction of the cost. For that reason it opened a window on how future fuel cell applications could readily and safely integrate more cost effective energy packages within the built environment as fuel cell services seek to become more commonplace within DOD and across America.

In achieving 97% operating availability at an energy cost addition of less than $1000 dollars over incumbent utility services, this project can only be considered successful. When one considers that the Air Force is pursuing additional fuel cell development work at Robins AFB, GA (CERL/C2P2 project), involving product evaluation of 10 of the next generation Plug Power models, this project must be viewed as contributory toward the Air Force's expanding interest in fuel cell commercialization.

In sum, LOGAN believes that the Hill AFB project achieved all of its programmatic objectives, that it has contributed to a greater understanding of fuel cell benefits within the DOD community, and that those lessons will apply equally to the broader objectives of the fuel cell industry and product commercialization.

Appendix

1. Performance Graphs

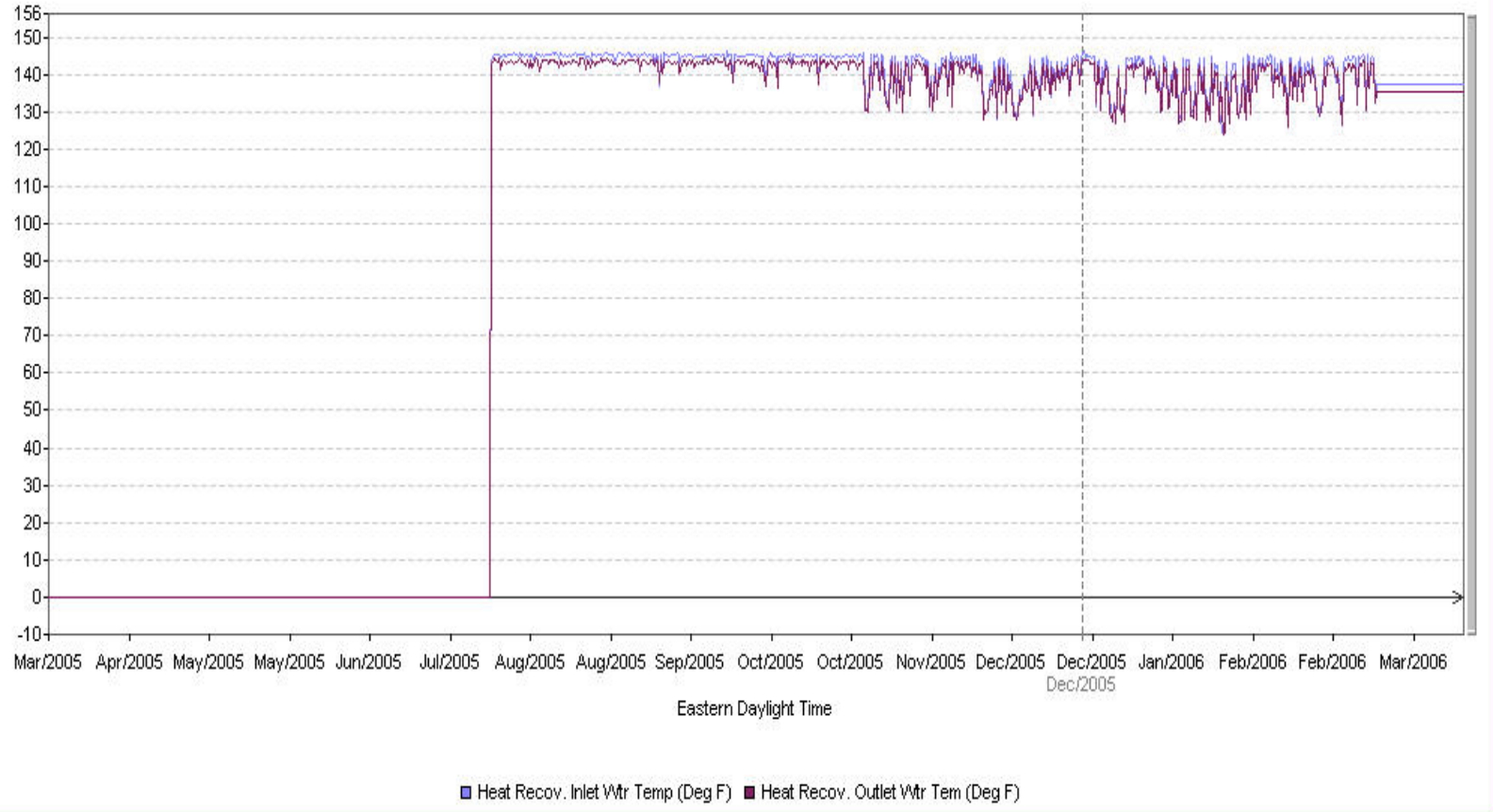


Figure 11, Daily Heat Recovery Temperature Delta from July 2005 through March 2006 in KBTU/H

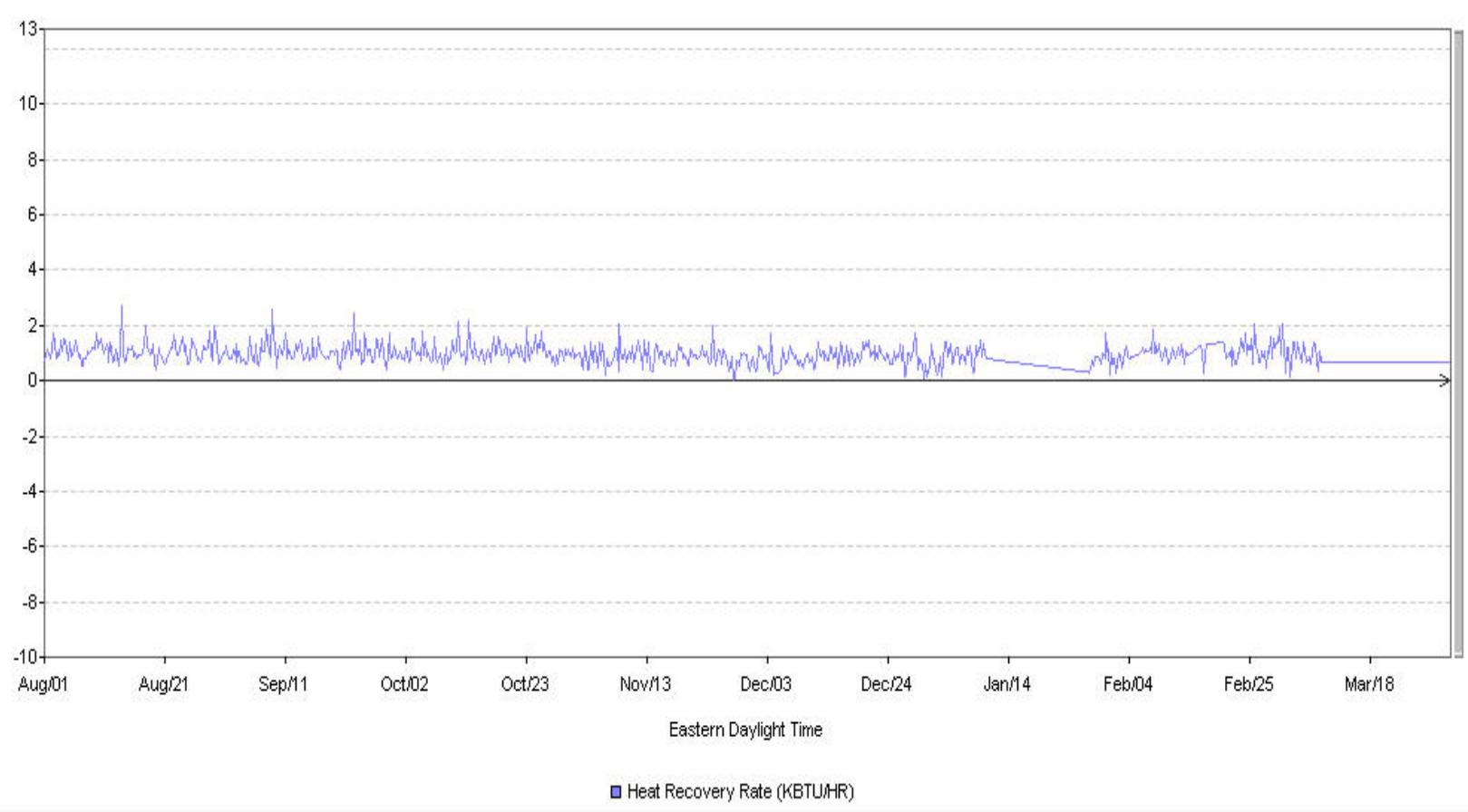


Figure 12, Daily Heat Recovery Rate in KBTU/hr. from July 2005 through March 2006

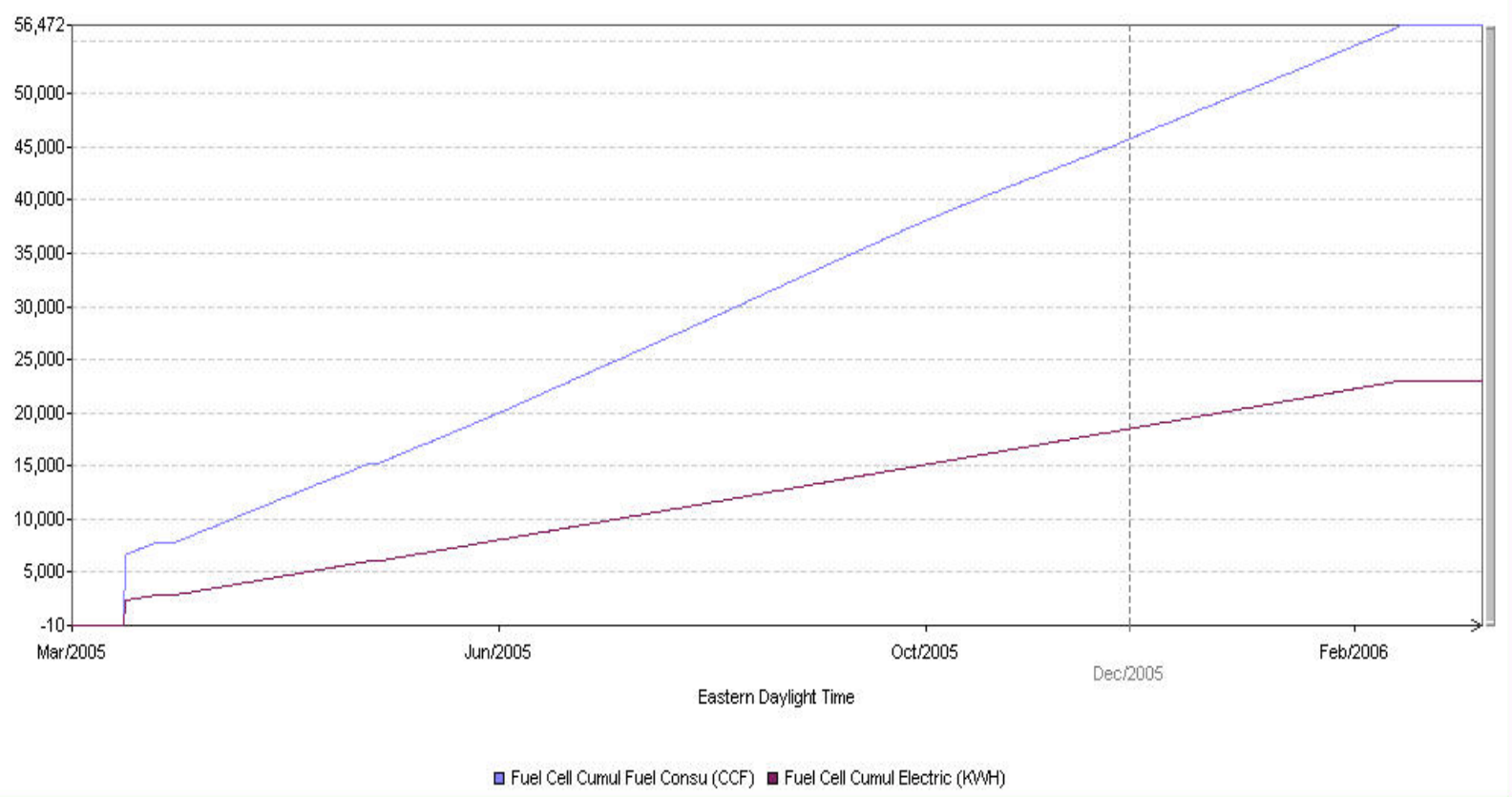


Figure 13, Plot of cumulative fuel consumption, blue line, over cumulative power, red line

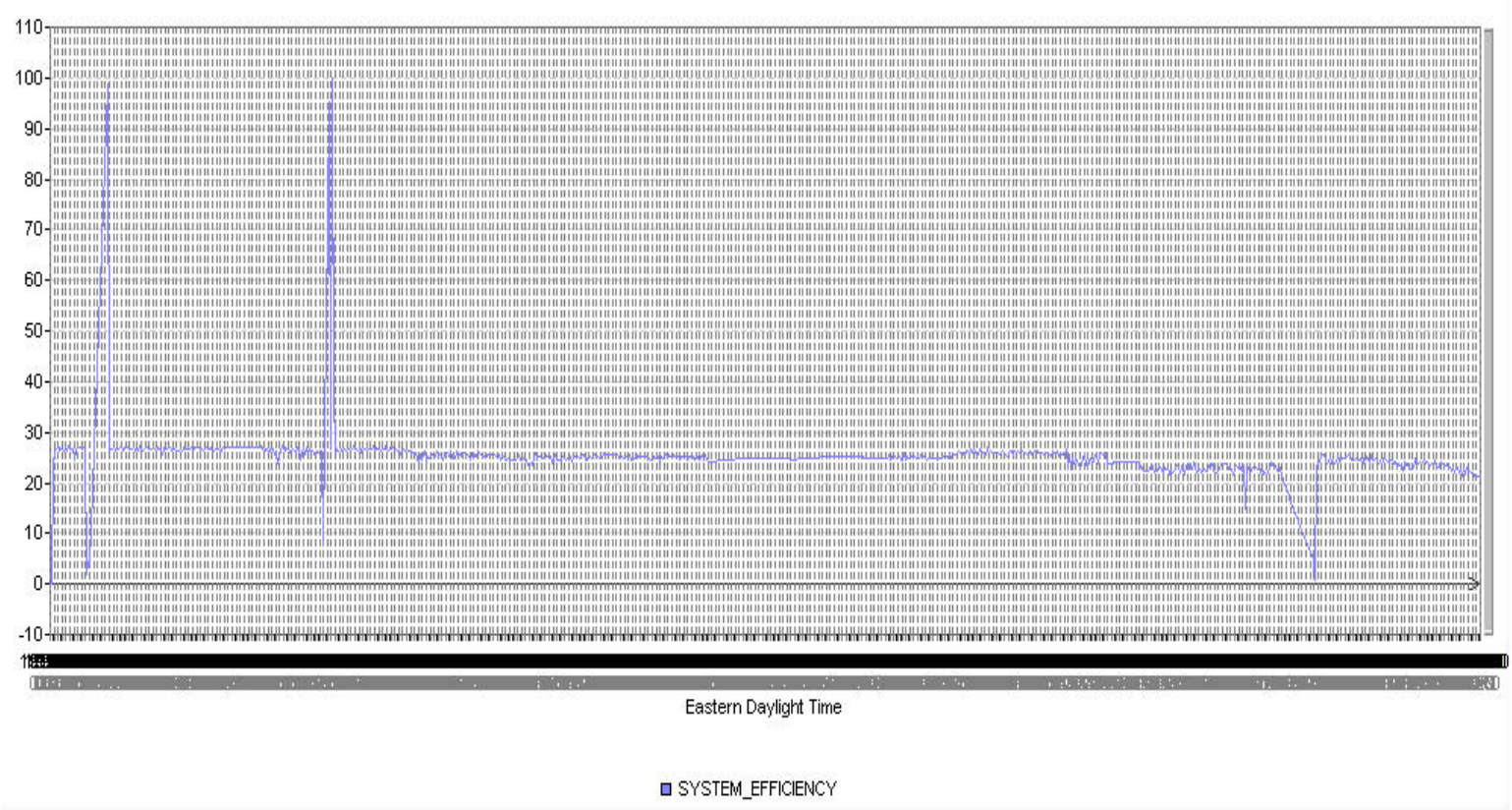


Figure 14, Overall System Efficiency (%) from March 2005 through March 2006

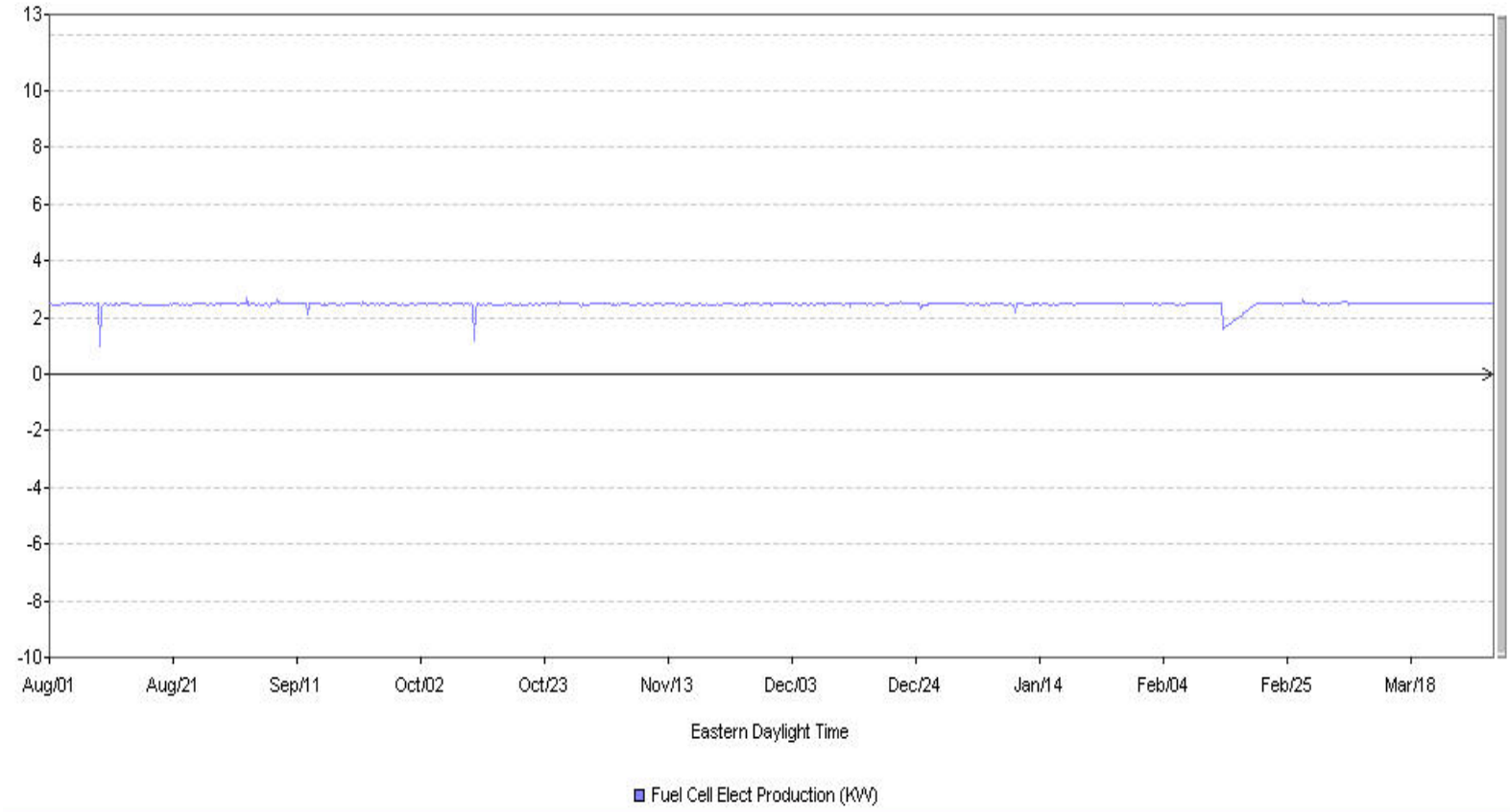
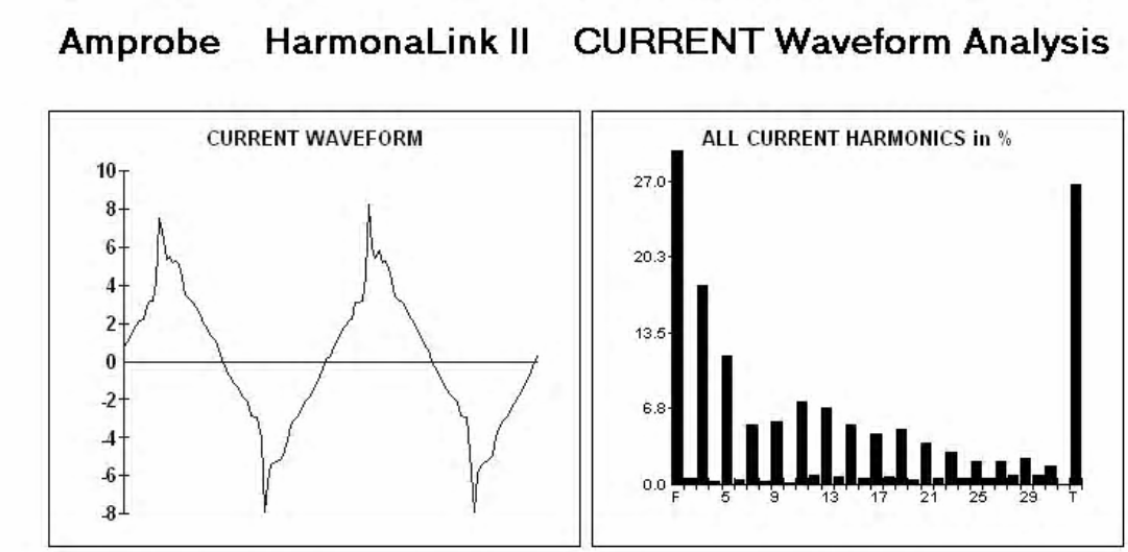


Figure 15, Fuel Cell Electrical Production

2. Additional Analysis - Current Waveform and Voltage Waveform Harmonics



CURRENT ODD HARMONICS

H	%	RMS	Angle
1	100.0	3.32	+0
3	17.7	0.59	-146
5	11.4	0.38	+80
7	5.2	0.17	-27
9	5.6	0.18	-132
11	7.3	0.24	+102
13	6.8	0.23	-42
15	5.3	0.18	-165
17	4.5	0.15	+88
19	4.8	0.16	-23
21	3.7	0.12	-149
23	2.9	0.10	+74
25	1.9	0.06	-42
27	2.0	0.07	+179
29	2.2	0.07	+58
31	1.6	0.05	-46
TripIn	19.8	0.66	
Odd	26.7	0.89	
THD	26.7	0.89	

CURRENT EVEN HARMONICS

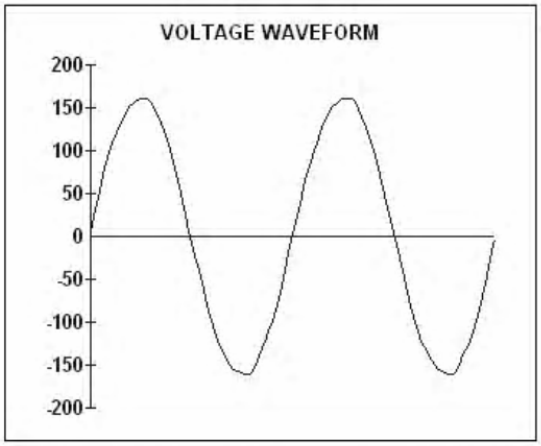
H	%	RMS	Angle
2	0.5	0.02	+155
4	0.3	0.01	+0
6	0.4	0.01	-156
8	0.2	0.01	-126
10	0.1	0.00	-28
12	0.7	0.02	-72
14	0.6	0.02	+132
16	0.4	0.01	+22
18	0.6	0.02	-111
20	0.4	0.01	+153
22	0.4	0.01	+29
24	0.5	0.02	-88
26	0.5	0.02	+128
28	0.7	0.02	-15
30	0.8	0.03	-131
Even	2.0	0.06	

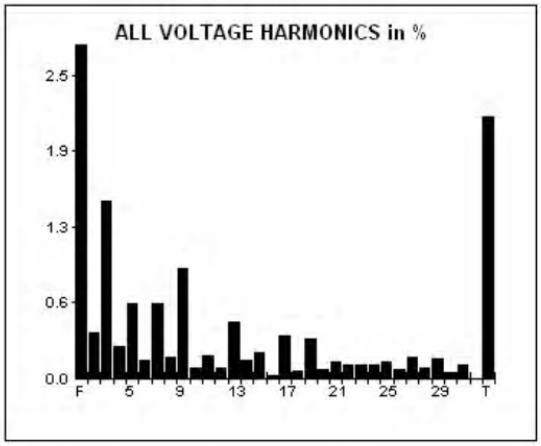
CURRENT TOTALS

Total	3.44 rms
Peak	8.07
Average	2.87
DC Comp	0.08
Crest Factor	2.35
Form Factor	1.20
Fund Freq	60.00 Hz
Fundamental	3.32 rms
Harmonics	0.89 rms
THD Percent	26.7%
K Fctr	7.31

Figure 16, Current Waveform Analysis

Amprobe HarmonaLink II VOLTAGE Waveform Analysis





VOLTAGE ODD HARMONICS

H	%	RMS	Angle
1	100.0	114.83	+0
3	1.5	1.67	+50
5	0.6	0.71	-102
7	0.6	0.70	+148
9	0.9	1.04	-174
11	0.2	0.21	+46
13	0.5	0.54	+180
15	0.2	0.24	-130
17	0.3	0.40	-17
19	0.3	0.37	-98
21	0.1	0.15	-99
23	0.1	0.12	+41
25	0.1	0.15	-142
27	0.2	0.19	-108
29	0.2	0.19	-39
31	0.1	0.13	-108
TripIn	1.8	2.01	
Odd	2.1	2.39	
THD	2.2	2.48	

VOLTAGE EVEN HARMONICS

H	%	RMS	Angle
2	0.4	0.43	+155
4	0.3	0.29	-173
6	0.1	0.17	+160
8	0.2	0.19	-153
10	0	0	
12	0	0	
14	0.2	0.18	-123
16	0	0	
18	0	0	
20	0	0	
22	0.1	0.12	+18
24	0.1	0.12	-52
26	0	0	
28	0	0	
30	0	0	
Even	0.6	0.67	

VOLTAGE TOTALS

Total	114.86 rms
Peak	159.95
Average	103.50
DC Comp	0.35
Crest Factor	1.39
Form Factor	1.11
Fund Freq	60.00 Hz
Fundamental	114.83 rms
Harmonics	2.48 rms
THD Percent	2.2%
K Fctr	1.03

Figure 17, Voltage Waveform Analysis

3. Monthly Performance Data

Hill Air Force Base Fire Station, Building #9

Hill AFB, Utah

	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06
Run Time (Hours)	658	577	720	680	720	744	744	720	744	720	744	744	672	191
Time in Period (Hours)	658	744	720	744	720	744	744	720	744	720	744	744	672	191
Availability (%)	100%	78%	100%	91%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Energy Produced (kWe-hrs AC)	1678.0	1417.0	1774.0	1681.0	1789.4	1858.0	1830.9	1777.0	1836.0	1772.0	1843.4	1829.3	1671.7	476.3
Output Setting (kW)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Average Output (kW)	2.55	2.46	2.46	2.47	2.49	2.50	2.46	2.47	2.47	2.46	2.48	2.46	2.49	2.49
Capacity Factor (%)	51.00%	38.09%	49.28%	45.19%	49.71%	49.95%	49.22%	49.36%	49.35%	49.22%	49.55%	49.17%	49.75%	49.87%
Fuel Usage, LHV (kWe-hrs AC)	6338.0	5376.0	6715	6435	6977	7495	7380	6850	7365	6970	8033	7500	6479	1840
Fuel Usage, LHV (BTUs)	2.16E+07	1.83E+07	2.29E+07	2.20E+07	2.38E+07	2.56+07	2.52E+07	2.34E+07	2.51E+07	2.38E+07	2.74E+07	2.56E+07	2.21E+07	6.28E+06
Fuel Usage (SCF)	21379	18134	22650	21706	23534	25281	24894	23106	24843	23511	27096	25298	21854	6207
Electrical Efficiency (%)	26.49%	26.37%	26.43%	26.14%	25.66%	24.80%	24.82%	25.96%	24.94%	25.44%	22.96%	24.40%	25.82%	25.90%
Thermal Heat Recovery (BTUs)	0	0	0	0	0	5381500	798900	750400	697600	621200	612200	514400	70990	200700
Heat Recovery Rate (BTUs/hour)	0	0	0	0	0	7233.1989	1073.7903	1042.2222	937.6344	862.7778	822.8495	691.3978	105.6399	1050.7853
Thermal Efficiency (%)	0.00%	0.00%	0.00%	0.00%	0.00%	21.04%	3.17%	3.21%	2.78%	2.61%	2.23%	2.01%	0.32%	3.20%
Overall Efficiency (%)	26.49%	26.37%	26.43%	26.14%	25.66%	45.85%	28.00%	29.17%	27.72%	28.05%	25.19%	26.42%	26.14%	29.10%
Number of Scheduled Outages	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scheduled Outage Hours	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Unscheduled Outages	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Unscheduled Outage Hours	0	167	0	64	0	0	0	0	0	0	0	0	0	0

4. Daily Work Logs

LOGANEnergy Field Technicians

July '04 – October '05

LOGANEnergy Corp.					
Monthly Site Report					
Period	July-04				
Site	Hill AFB				
Engineer	**Date**	**PP S/N**	**Activity**	**Mileage**	**Hours**
Collard	7/19/2004	320	Either location at Hill will provide a significant heat recovery load to the water heater. There are only two adults living in the house therefore showers and laundry would be minimal. There is a significant demand for heat six or so months out of the year. Maybe we could install a small liquid to air heat exchanger in the basement and it could provide most of the heat they would need there. I'm trying to figure a way of getting the most out of the machine.		

LOGANEnergy Corp.					
Monthly Site Report					
Period	January-05				
Site	Hill AFB				
Engineer	**Date**	**PP S/N**	**Activity**	**Mileage**	**Hours**
	1/25/2005	320	The FC is placed and we started to install the piping. The temp went all the way up to 32 deg/F today. We had to find some way to route our electrical conduits to the panel but I think we have a handle on it.		
Collard	1/26/2005	320			
			We had a good day in the frozen tundra of Hill AFB. Temp shot all the way up to 32 deg/F from the overnight low of 25. We got most of the piping outside done, the Connected Energy box mounted and the electrical boxes interconnected. We hope to have the electrical complete tomorrow and most of the heat recovery.		
			The personnel here are very cooperative and interested in what is going on. I am going to contact Quest communications in the morning to get the DSL going. They are not 100% sure it will work at this location.		
			Continued installation. Installed electrical and heat recovery piping. Mounted CE box.	36	16
	1/31/2005	320			
			We completed the heat recovery with the plumber. I need to insulate tomorrow and add glycol to the loop. We installed the bollards in front of the FC. That was a real chore. We had to rent a demo hammer to get through the 6 inch thick asphalt.		
			We started the FC and it came up with no problems. It is running great.		

LOGANEnergy Corp.					
Monthly Site Report					
Period	March-05				
Site	Hill AFB				
Engineer	**Date**	**PP S/N**	**Activity**	**Mileage**	**Hours**
	3/14/2005	320			
			1110826535,3/14/2005 1:55:35 PM,Manual (20)ALERT, PHONE_LINE1_BAD_MODEM_RESPONSE, Error Code: (120)(0)		
			1110826579,3/14/2005 1:56:19 PM,Manual (20)ALERT, PHONE_LINE1_PASSED, Error Code: (115)(0)		
			1110826627,3/14/2005 1:57:07 PM,Manual (20)ALERT, PHONE_LINE2_PASSED, Error Code: (123)(0)		
			1110826736,3/14/2005 1:58:56 PM,Reformer Purge (31)EVENT, STARTUP_EVENT, Error Code: (1000)(0)		
			1110828709,3/14/2005 2:31:49 PM,Reformer Purge (31)ESTOP, FUEL_AIR_BLOWER_FAILED_HIGH, Error Code: (626)(0)		
			1110828709,3/14/2005 2:31:49 PM,Unknown (106)EVENT, SHUTDOWN_EVENT, Error Code: (1001)(0)		
			1110828714,3/14/2005 2:31:54 PM,ESTOP (107)ESTOP, HW_ESTOP_SARC_L0, Error Code: (534)(0)		
	3/24/2005	320			
			1111666181,3/24/2005 7:09:41 AM,Reformer Purge (31)EVENT, STARTUP_EVENT, Error Code: (1000)(0)		
			1111667711,3/24/2005 7:35:11 AM,Reformer Warmup (32)ALERT, RECOVER_RADIATOR_FAN, Error Code: (557)(0)		
			1111667711,3/24/2005 7:35:11 AM,Reformer Warmup (32)SHUTDOWN, LOSS_RADIATOR_FAN, Error Code: (540)(0)		
			1111667711,3/24/2005 7:35:11 AM,SD Ref Cool (104)EVENT, SHUTDOWN_EVENT, Error Code: (1001)(0)		
	3/29/2005	320			
			1112105876,3/29/2005 9:17:56 AM,Power Down (200)ALERT, REMOTE_REQUESTED_ESTOP, Error Code: (601)(0)		
			1112106819,3/29/2005 9:33:39 AM,Reformer Purge (31)EVENT, STARTUP_EVENT, Error Code: (1000)(0)		
	3/31/2005	320			
			1112290838,3/31/2005 12:40:38 PM,Running (51)ALERT, LOW_CELL_TRIP_ALERT, Error Code: (500)(0)		
			1112290853,3/31/2005 12:40:53 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		

LOGANEnergy Corp.					
Monthly Site Report					
Period	April-05				
Site	Hill AFB				
Engineer	**Date**	**PP S/N**	**Activity**	**Mileage**	**Hours**

	4/1/2005	320	1112387968,4/1/2005 3:39:28 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/2/2005	320	1112460186,4/2/2005 11:43:06 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/3/2005	320	1112504811,4/3/2005 12:06:51 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/4/2005	320	1112587393,4/4/2005 12:03:13 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/5/2005	320			
			1112696904,4/5/2005 6:28:24 AM,Running (51)ALERT, GRID_LOSS, Error Code: (632)(0)		
			1112696904,4/5/2005 6:28:24 AM,Running (51)ALERT, SYSTEM_TRANSITIONED_TO_STANDBY, Error Code: (630)(0)		
			1112696915,4/5/2005 6:28:35 AM,Run-GL-SB (53)ALERT, SYSTEM_TRANSITIONED_TO_GRID, Error Code: (631)(0)		
			1112696919,4/5/2005 6:28:39 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/6/2005	320	1112812090,4/6/2005 2:28:10 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/7/2005	320			
			1112880631,4/7/2005 9:30:31 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
			1112922393,4/7/2005 9:06:33 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/8/2005	320	1112932801,4/8/2005 12:00:01 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/9/2005	320	1113019986,4/9/2005 12:13:06 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/10/2005	320	1113154440,4/10/2005 1:34:00 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/11/2005	320	1113235050,4/11/2005 11:57:30 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/12/2005	320	1113307166,4/12/2005 7:59:26 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/13/2005	320	1113385961,4/13/2005 5:52:41 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/14/2005	320	1113470213,4/14/2005 5:16:53 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		

	4/15/2005	320	1113591147,4/15/2005 2:52:27 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/16/2005	320	1113668536,4/16/2005 12:22:16 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/17/2005	320	1113756735,4/17/2005 12:52:15 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/18/2005	320	1113797075,4/18/2005 12:04:35 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/19/2005	320	1113921785,4/19/2005 10:43:05 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/20/2005	320	1113997130,4/20/2005 7:38:50 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/22/2005	320	1114197407,4/22/2005 3:16:47 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/23/2005	320			
			1114272436,4/23/2005 12:07:16 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
			1114272864,4/23/2005 12:14:24 PM,Running (51)ALERT, LOW_CELL_TRIP_ALERT, Error Code: (500)(0)		
	4/24/2005	320	1114324356,4/24/2005 2:32:36 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/26/2005	320	1114537317,4/26/2005 1:41:57 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/27/2005	320	1114610610,4/27/2005 10:03:30 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	4/28/2005	320	1114719428,4/28/2005 4:17:08 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		

LOGANEnergy Corp.					
Monthly Site Report					
Period	May-05				
Site	Hill AFB				
Engineer	**Date**	**PP S/N**	**Activity**	**Mileage**	**Hours**
	5/1/2005	320	1114974719,5/1/2005 3:11:59 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/2/2005	320	1115023093,5/2/2005 4:38:13 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/3/2005	320	1115144779,5/3/2005 2:26:19 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code:		

			(638)(0)		
	5/4/2005	320	1115220458,5/4/2005 11:27:38 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/5/2005	320	1115290204,5/5/2005 6:50:04 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/6/2005	320	1115355518,5/6/2005 12:58:38 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/7/2005	320	1115508945,5/7/2005 7:35:45 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/8/2005	320			
			1115539059,5/8/2005 3:57:39 AM,Running (51)ALERT, LOW_CELL_TRIP_ALERT, Error Code: (500)(0)		
			1115539075,5/8/2005 3:57:55 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/9/2005	320	1115661173,5/9/2005 1:52:53 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/10/2005	320	1115726396,5/10/2005 7:59:56 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/11/2005	320	1115784943,5/11/2005 12:15:43 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/13/2005	320	1116002852,5/13/2005 12:47:32 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/14/2005	320	1116083515,5/14/2005 11:11:55 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/15/2005	320	1116162620,5/15/2005 9:10:20 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/16/2005	320	1116216070,5/16/2005 12:01:10 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/17/2005	320	1116346451,5/17/2005 12:14:11 PM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/18/2005	320	1116390200,5/18/2005 12:23:20 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/19/2005	320	1116475311,5/19/2005 12:01:51 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/20/2005	320	1116561689,5/20/2005 12:01:29 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
	5/21/2005	320	1116686087,5/21/2005 10:34:47 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code:		

			(638)(0)		
	5/22/2005	320			
			1116760763,5/22/2005 7:19:23 AM,Running (51)ALERT, FS3_REFORMER_AIR_FLOW_OUT_OF_RANGE, Error Code: (638)(0)		
			1116795469,5/22/2005 4:57:49 PM,Running (51)ALERT, LOW_CELL_TRIP_ALERT, Error Code: (500)(0)		
			1116795502,5/22/2005 4:58:22 PM,Running (51)ESTOP, HW_ESTOP_FG1_L5, Error Code: (531)(0)		
			1116795502,5/22/2005 4:58:22 PM,Running (51)ESTOP, HW_ESTOP_FG3_L6, Error Code: (532)(0)		
			1116795507,5/22/2005 4:58:27 PM,Running (51)ALERT, GRID_LOSS, Error Code: (632)(0)		
			1116795507,5/22/2005 4:58:27 PM,Running (51)ALERT, SYSTEM_TRANSITIONED_TO_STANDBY, Error Code: (630)(0)		
			1116795509,5/22/2005 4:58:29 PM,Run-GL-SB (53)ALERT, SYSTEM_TRANSITIONED_TO_GRID, Error Code: (631)(0)		
			1116795515,5/22/2005 4:58:35 PM,Running (51)SHUTDOWN, LOSS_FUEL_AIR_BLOWER, Error Code: (545)(0)		
			1116795515,5/22/2005 4:58:35 PM,SD Ref Cool (104)EVENT, SHUTDOWN_EVENT, Error Code: (1001)(0)		
			1116795517,5/22/2005 4:58:37 PM,SD Ref Cool (104)SHUTDOWN, LOSS_ATO_BLOWER, Error Code: (546)(0)		

LOGANEnergy Corp.					
Monthly Site Report					
Period	October-05				
Site	Hill AFB				
Engineer	**Date**	**PP S/N**	**Activity**	**Mileage**	**Hours**
Altemoos	10/25/2005	320	Maintenance conducted, no problems, phone line inside building punched down to wrong pairs? Problem identified and corrected, waiting for themonol, machine running.	3000	5